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Drinking Behavior in the Red Kangaroo *(Megaleia rufa)* and the Euro *(Macropus robustus)*

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Introduction

One of the important environmental factors which must influence the distribution of an animal in an arid environment is the availability of water, either free or in its food. Two species of large kangaroo, the red kangaroo *(Megaleia rufa)* and the euro *(Macropus robustus erubescens)* are found over a large part of the arid and semi-arid areas of Australia, and their water requirements and the extent to which these influence distribution and mobility have been the subject of speculation and inference from diet and observed distribution. The determination of how often and how much individual animals drink requires that one should mark animals, or learn to recognize individuals, and follow their drinking pattern (for some time). One must have the means of following animals which do not drink always at the same place when alternative sources of water are available. In the Pilbara region of Western Australia, Ealey (1967), from records of automatic counters at watering points and direct observation of marked euros, found increased drinking activity as summer progressed, but that few animals drank regularly, even when daytime temperatures exceeded 43° C, and that many apparently never drank at all. Ealey, Bentley and Main (1965) found that over seven days, 196 euros drank 451 l, at an average of 2.3 l per animal. This does not represent daily individual consumption, and animals may have been drinking at more than one place.

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The pattern of drinking behavior is of interest in the comparison of the adaptations of red kangaroos and euros to the same environment, when they occur together. Observations of the drinking behavior of red kangaroos and euros drinking at the same source of water were made in December, 1968 at Fowler's Gap, the Arid Zone Research Station of the University of New South Wales. Observations of drinking rates were made at the School of Zoology and the Cowan Field Station of the University of New South Wales in Sydney.

Methods

Observations were made at the University of N.S.W. Arid Zone Research Station at Fowler's Gap in the northwest of N.S.W. (Longitude 142° E, Latitude 31° S). The station falls within the 20 cm per annum isohyet, and rainfall is variable throughout the year and from year to year. Air temperatures commonly reach 42° C and values of 45° C are not infrequent. Evaporation exceeds 250 cm per year, and there is little free water in a dry summer, apart from water provided for stock.

The water observed was an artificial lake in an area surrounded by rocky hills, in which were caves and gullies frequently used as shelters by euros. The dam was within 1500 m of open plains country frequented by red kangaroos. Vegetation within 50 m of the water had been close-cropped by sheep, which made it easy to see animals approaching the water. Observations were made from one end of the lake. The observers were in position one hour before recording commenced. On five days (14 December — 18 December), observations were made from 16.00 hrs until 20.00 hrs. On two days (14 December and 18 December), observations were continued throughout the night until 12.00 hrs next day. At night, animals were detected by a rapid sweep with a spotlight once every 30 mins. During the period of observation, daily maximum temperatures ranged from 23° C to 39.3° C.

Detailed observations of animals drinking were made during the pre-dusk period, and the following data were recorded:

a. Time spent within 5 m of the water, as times of arrival and departure; sex and age (adult or juvenile); presence and age of a young in the pouch of a female, estimated where possible on the basis of experience with pouch young of known age in captive animals (E.M.R.).

b. Duration of all periods when the animals were actually drinking. From these records were calculated: total time spent drinking; proportion of time spent within 5 m of the water actually drinking; number and duration of all short periods of drinking. The first two animals to appear each day were recorded in this way, and as soon as one left, its observer began to record the next animal to begin drinking. Data on the time of day at which animals drank is not presented since it relates only to the particular site at which observations were made.

Measurements of the volume of water drunk in a known time were made on animals in captivity. Four adult female red kangaroos were kept in cages 3.5 m × 1.5 m at the School of Zoology. Normally they were fed crushed oats and lucerne chaff and given unlimited water. After twenty-four hours water deprivation (similar to the usual minimum period without water experienced by animals in the field), water was placed in the cages, and the duration of drinking and the volume drunk was measured. The experiment was continued for 9 days. Most drinking occurred during the first 15 mins. Similar measurements were made on five *Macropus robustus robustus* (3 ♂ and 2 ♀) and one ♀ *M. r. erubescens*. Daily maximum temperatures ranged from 26° C to 32° C during the period when these measurements were made.

Throughout, mean values are given with 95% confidence intervals.

Results

Field Observations

1. Approach to Water and Drinking

Red kangaroos and euros came in to drink at the lake throughout the night, but the largest numbers were seen at dusk. Red kangaroos and euros were seen drinking side by side. Approach to water and drinking were very similar for the two species, and the description given is applicable to both species, seen at dusk. Most animals approach-

ed the water slowly. They appeared up to one hour before they came to the water, and moved about on the slopes within 100 m of the water, apparently feeding. No more than three animals approached in a group, and all males were seen alone. Animals gradually moved closer to the water, and approached directly but slowly, over the last 20 m often on all four limbs in the form of locomotion called crawling by FRITH and CALABY (1969). Kangaroos drinking were easily disturbed by the approach of other kangaroos and by birds. When disturbed, animals leapt quickly away from the water, and sometimes moved away from the area, or remained close to the water and approached again after a short interval. After they had finished drinking, kangaroos moved away from the water as slowly as they had come. A few animals approached the water directly, as soon as they came into view, and large adult males of both species generally did so, although they crossed the last 20 m or so by „crawling". When they drank, both red kangaroos and euros stood right at the edge of the water and bent forward, with forelimbs held clear of the water. Movement of the tongue could be seen from a distance, and the noise of drinking was audible at a distance of 10 m.

2. *Detailed Records of Drinking*

The results of the detailed recording of drinking are summarised in Table I. Since comparatively few juveniles and adult males were recorded in this way, the results for known females are shown separately, together with the results for all animals. Scores for adult males were very variable. Values of total time spent drinking ranged from 104 secs to 2167 secs for male red kangaroos. Clear differences can be seen between the females of the two species. The mean time of 980 ± 182 secs spent within 5 m of the water by female euros is significantly larger than the mean for female red kangaroos of 701 ± 174 secs. Although euros spent proportionately less of this time drinking, nevertheless the females drank for a significantly longer time (551 ± 141 secs) than did female red kangaroos (383 ± 84 secs). When male and female scores are considered together, the difference in total time spent drinking is not significant, due probably to the variable scores for males. The duration of short periods of drinking is not significantly different for the two species, and since euros spent longer actually drinking, the number of short periods of drinking is greater for euros.

One day on which observations were made (16 December) was a relatively cool day (maximum temperature 23.6° C). The scores of total time drinking for 14 females on 16 December were compared with the scores for 24 females on all other days. The difference was not significant ($t = 1.71$, $P > .05$).

If lactation imposes significant extra water requirement upon females, females with large pouch young should drink more than females with no pouch young, or very small pouch young. There was no significant difference in the time drinking by females with pouch young estimated as more than 100 days and females with no pouch young or pouch young estimated as less than 100 days, for red kangaroos ($t = 1.21$, $P > .05$, $N_1 = 10$, $N_2 = 11$), or euros ($t = 0.40$, $P > .05$, $N_1 = 7$, $N_2 = 9$).

The mean rate of drinking calculated for four female *Megaleia rufa* after 24 hours without water was 5.1 ± 0.4 ml sec^{-1}. The rate of drinking measured in three male and three female *Macropus robustus* was 4.1 ± 1.0 ml sec^{-1}, which is not significantly different from the rate calculated for *Megaleia rufa*.

Discussion

The slow approach to water reported by EALEY (1967) for euros was observed in both red kangaroos and euros in the present study, but we saw no signs that the

Comparison of means of five measures of drinking behavior for red kangaroos and euros

		Time Spent on Edge of Dam (secs.)		Total Time Spent Drinking (secs.)		Percentage of time at Dam Spent Drinking		Number of Drinks		Mean duration of Drinks	
		♀	all	♀	all	♀	all	♀	all	♀	all
Red Kangaroos	$\bar{x}$	603	701	383	472	65.6	65.8	14.5	16.6	29.4	30.0
	±[1]	105	174	84	162	6.8	5.8	3.6	3.9	6.8	6.4
	N	33	43	22	26	22	26	22	26	22	26
Euros	$\bar{x}$	925	980	550	540	55.9	54.7	21.9	23.2	27.4	25.4
	±[1]	172	182	141	111	5.3	4.7	7.6	6.6	7.1	5.4
	N	34	48	16	23	16	23	16	23	16	23
Red Kangaroos/ Euros	t	3.58	2.34	2.48	0.71	2.33	3.37	2.16	2.06	0.42	1.13
	P	< 0.001	< 0.05	< 0.02	> 0.05	< 0.05	< 0.01	< 0.05	< 0.05	> 0.05	> 0.2

[1] 95 % Confidence Intervals

animal were approaching against the wind as EALEY observed. Since the area of water was large, there was no question of any one animal taking precedence over others, as EALEY suggests may happen at smaller soaks and troughs, but the interactions between animals suggest that this could occur. From the rate at which animals drank which had been kept in cages and deprived of water for 24 hours, and from field measurements of the mean time drinking, it can be calculated that an approximate figure for the volume of water drunk by female red kangaroos at Fowler's Gap was 1.9 l. A similar estimate of the volume drunk by female euros gives a figure of 2.2 l. In view of the approximations involved in these estimates, they can only be taken as indicating that the amount of water drunk by adult females of both species was of the order of 2 l. This figure is comparable with the value of 2.3 l obtained by EALEY, BENTLEY and MAIN (1965). The time spent near water and the time spent drinking by red kangaroos and euros appear longer than those quoted from animals in the desert such as the camel or donkey, quoted by SCHMIDT-NIELSEN (1964), who says that donkeys in the Sahara could make up water losses as great as 20 % of body weight in less than two minutes. SCHMIDT-NIELSEN stresses the biological importance for an animal which can drink rapidly and to full capacity, escaping predators lurking near a waterhole. The relatively long time spent near water by these two species of kangaroo may reflect a lack of predators.

Lactation did not seem to impose a significant water requirement upon a female, since there was no difference in the time spent drinking by females with large and small pouch young. Evaporative

water loss in thermoregulation is the major avenue of water loss (Schmidt-Nielsen 1964), compared with which the requirements of lactation must be small.

Red kangaroos and euros differ in their utilization of different types of shelter in hot weather. Euros at Fowler's Gap shelter chiefly in hilly areas, in caves or under ledges, but they also use the shelter of dense shrubs (Russell 1969). Red kangaroos inhabit more open country, where the only shelter may be small trees such as *Casuarina* sp. or *Acacia* spp. Dawson and Denny (1968) found that in a typical red kangaroo shelter, the heat load for an animal was greater than in any of the typical euro shelters, largely due to incoming solar radiation. Red kangaroos would thus require more water for thermoregulation. Dawson and Denny (1969) found that urine osmolality was generally higher in red kangaroos than in euros, and suggest on the basis of patterns of excretion of sodium and potassium, that differences in the type of vegetation eaten by the two species may be a major factor contributing to the different urine osmolality values, although environmental temperature had some effect. The similarity of estimates of the volume drunk by females of each species suggests that a difference in water requirements will be reflected more by differences in the frequency than in the volume drunk at any one time.

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Summary

Observations are reported of drinking by red kangaroos and euros in north-western New South Wales. Euros spent more time than red kangaroos close to the water, and drank for a longer time, although slightly less of their time at water was spent drinking. Females with large pouch young did not drink for significantly longer times than other females. Estimates of rates of drinking suggest that the volume drunk was of the order of two litres

Zusammenfassung

Beobachtungen über das Trinken bei den Känguruhen *Megaleia rufa* and *Macropus robustus* im norwestlichen Neusüdwales, Australien, werden berichtet. *Macropus robustus* bleibt länger als *Megaleia rufa* dicht beim Wasser, und trinkt länger, obwohl sie nur einen kleineren Teil der Zeit, welche sie im Wasser sind, trinken. Die Weibchen mit großen Jungen im Beutel haben nicht signifikant länger als die anderen Weibchen getrunken. Schätzungen über die Trinkgeschwindigkeit deuten darauf hin, daß etwa zwei Liter getrunken wurden.

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